

# ATM05 2021

Application of Machine Learning Techniques for the retrieval of Cloud Properties for the Copernicus Satellites Sentinel-4 (S4) and TROPOMI / Sentinel-5 Precursor (S5P)

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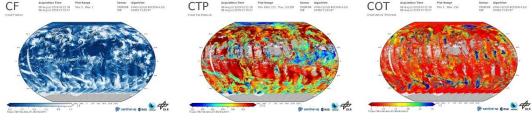
Application of Machine Learning Techniques for the retrieval of Cloud Properties for the Copernicus Satellites Sentinel-4 (S4) and TROPOMI / Sentinel-5 Precursor (S5P)



1. Sentinel-5 Precursor (S5P) and Sentinel-4 (S4) are passive earth observation satellites DLR is responsible for the operational CLOUD product

Inversion with NN as Forward Model

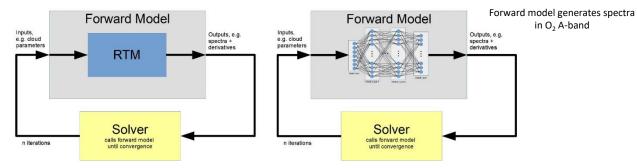
in O<sub>2</sub> A-band



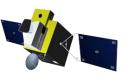
S5P operational CLOUD product

**Challenge:** Near real time requirements (NRT) for large amounts of data Solution: Use neural network (NN) instead of radiative transfer model (RTM) in retrieval:

Inversion with RTM as Forward Model



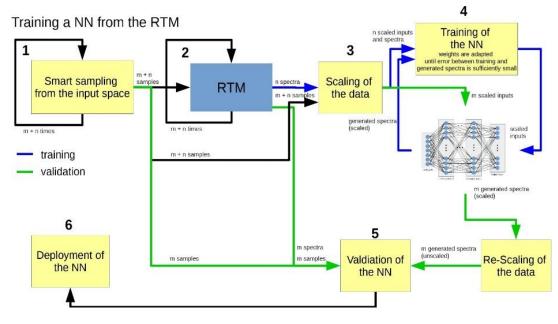




Sentinel-5P

Sentinel-4

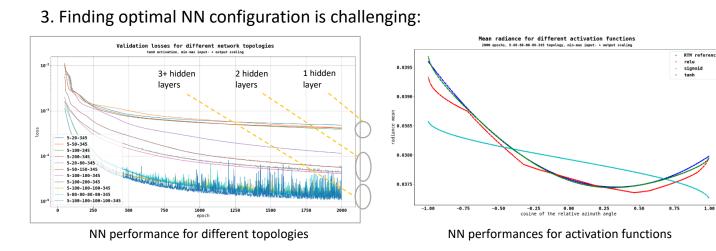
### 2. How to replace RTM by NN? $\rightarrow$ NNLifecycle chain:



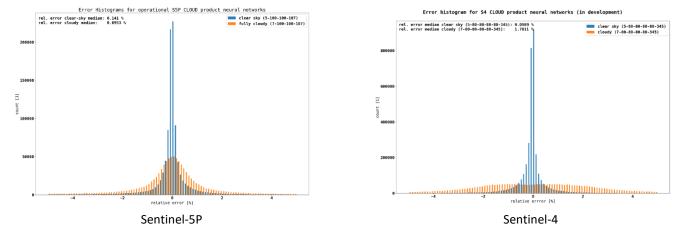
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#### 4. Operational Performance:



## 5. Conclusion and Impact:

 NNs offer way to drastically improve performance of classical retrieval algorithms

model	# parameters	exec. time	exec. time with grad.
RTM VLIDORT, 32 threads	-	17h, 9min,0.62 5s	-
S5P Clear Sky (5-100-100-107)	21507	0.62s	3.48s
S4 Clear Sky (5-80-80-80-80- 345)	47865	3.28s	14.67s

- many orders of Computational performance for generating 250000 spectra magnitude faster than RTMs
- allow meeting necessary NRT requirements of today's satellites
- 2. NN lifecycle chain offers general procedure for replacing RTM by NN  $\rightarrow$  allows use of specific NNs
- 3. NNs can provide sufficient accuracy to replace RTM
  - Finding the best structure / configuration is challenging

#### 4. NNs allow new possibilities for inversion algorithms

 Computational performance increase allows many forward model calls, gradients are available
→ Global optimization techniques

For further questions, please contact me: Fabian.Romahn@dlr.de

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